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a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic olefin resin (TPO) having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45; an ASTM D793 density at 23 degrees Celsius g/cm³ of about 0.88; and an ASTM D1693 environmental stress-cracking resistance, hours of about >3,000.

REMARKS

Status of the Claims

Claims 1-31, and 33-42 are pending. Claims 1 and 13 are amended for clarification purposes. Support for the amendment can be found on page 4 of the Specification. Accordingly, no new subject matter is added in the above amendment.

Applicant notes that the Office Action Summary has an inconsistency in that it indicates that 1-42 are pending. Claim 32 has been canceled as indicated in the previous Office Action Summary mailed May 22, 2001.

The Present Invention

The present invention is an improved composite chemical barrier fabric. The fabric of the present invention is improved because of the presence of the claimed durability layer. The durability layer comprises a thermoplastic

polyolefin (TOP). The multiple layer, chemical barrier material may be a prior art barrier material, such as the RESPONDER® fabric discussed in the specification.

The present invention (chemical barrier material and the thermoplastic polyolefin coating) provides a chemical barrier fabric that at least has a much improved puncture resistance and flex-crack resistance. The importance of puncture resistance and flex-crack resistance in the overall performance of chemical barrier fabric cannot be understated.

Examiner Interview

On November 27, 2001, an interview was conducted between Applicant's representative and Examiner Guarriello at the office of Examiner Guarriello.

The interview is accurately summarized on the Examiner Interview Summary Form, which has been made of record.

During the interview, all issues with respect to the outstanding Office Action were discussed, and the Examiner agreed to thoroughly review this Response. Some of the issues discussed during the interview are further discussed throughout this Response.

The time and attention of the Examiner during the interview are greatly appreciated.

Issues under 35 U.S.C. § 112, second paragraph

Claims 1-3, 6-19, and 22-40 are rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

The Office Action states that "it is not clear what the specific coating composition comprises..."

As stated in the Amendment filed August 22, 2001, the contents of which are incorporated herein by reference, the second paragraph of § 112 only requires the scope of claims to be reasonably precise. In re Borkowski, 154 USPQ 662 (CCPA 1970). Also, see In re Wiggins, 179 USPQ 421 (CCPA 1973).

The instant claims are definite because the independent claims specifically set forth the coating composition. The independent claims (claims 1, 13, 30, and 37) disclose that the "durability layer" is coated on the chemical barrier material, and the durability layer comprises a thermoplastic polyolefin.

The Office Action further states that the "Claims merely set forth physical characteristics...not setting forth specific compositions..." However, it is clearly stated in the claims that a thermoplastic polyolefin with the recited characteristics is coated in the chemical barrier material.

The fact that other factors are not further cited in the claim with respect to the durability layer serves, at best, to render the claim "broad", but not indefinite. As discussed during the interview, it is well settled that the breadth of a claim cannot, by itself, render a claim indefinite. In re Gardner, 166 USPQ

138 (CCPA 1970). Also, as discussed during the interview, in this instance, it should be the prior art that should determine the breath of the claim.

Finally, with respect to this rejection, the Office Action states that the claims are "vague, indefinite, and functional since they cover any conceivable combination of ingredients..." However, that statement is not true, and ignores the claimed thermoplastic polyolefin coating set forth in the claims. Additionally, regarding the functional language, "[t]here is nothing inherently wrong with defining some part of an invention in functional terms. Functional language does not, in and of itself, render a claim improper." In re Swinehart, 169 USPQ 226 (CCPA 1971). The functional language used in the present claims with respect to the puncture resistance and flex-crack resistance performance fairly conveys to a person of ordinary skill in the art characteristics of the claimed invention.

Issues under 35 U.S.C. § 102

Claims 1-3, 6-19, and 22-40 are rejected under 35 U.S.C. § 102(e) as allegedly being anticipated by Langley, U.S. 5,948,708. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

In the previous Office Action claims 1-3, 30, 31, 37, and 38 were rejected under 35 U.S.C. § 102 over the same Langley reference. However, Applicant's comments with respect to this rejection were not addressed in the outstanding Office Action.

As stated in the previous Amendment, this reference discloses a fabric comprising an inner layer, a flame resistant layer, and a reflectant layer. The flame resistant layer is disclosed as ideally being a woven fiberglass layer. The flame resistant layer may also comprise carbonized fibers, flame retardant rayon, flame retardant cotton, and flame retardant wool and aramid fibers. The reflectant layer is disclosed as being a metallized polyethylene terephthalate.

The cited reference fails to disclose a chemical barrier fabric comprising a thermoplastic polyolefin (TPO) of the present invention coated on at least one side of a multiple layer, chemical barrier material. Furthermore, the chemical barrier material of the '708 Patent does not consist of a thermoplastic polyolefin material of the present invention.

The Office Action fails to allege that a thermoplastic polyolefin coating is described in the reference, but asserts that the claims lack novelty - again ignoring the presence of the TPO in the claims.

As Applicant has stated in the record, in order to properly set forth a proper rejection under 35 U.S.C. § 102, the "identical invention must be shown in as complete detail as contained in the... claim." See Richardson v. Suzuki Motor Co., 9 U.S.P.Q.2d 1913, 1920 (Fed. Cir. 1989).

In view of the differences outlined above - that have not been resolved by the Office Action, it cannot be said that the '708 Patent discloses an identical invention as claimed.

To further emphasize Applicant's position that the Langley '708 patent is not an identical invention as required, it is known that a reflective surface such as the reflective layer of the Langley '708 patent can only maintain its thermal protective performance and radiant heat reflectance if coated with an infrared invisible layer. See cols. 5 and 6 of Langley '708. Thermoplastic polyolefins are not IR invisible, and therefore would essentially destroy the performance claimed in the Langley '708 patent if above the reflective layer.

Claims 1-31 and 33-40 are rejected under 35 U.S.C. § 102 (b) as allegedly be anticipated by Hauer et al., U.S. 5,626,947. This rejection is respectfully traversed. Reconsideration and withdrawal thereof are requested.

In the previous Office Action, claims 4-29, 33-36, and 39-42 were rejected under 35 U.S.C. § 103 over this reference. Again, Applicant's comments with respect to this rejection were not addressed in the outstanding Office Action. Applicant provided distinguishing remarks, and a Declaration demonstrating superior and unexpected results. The previous obviousness rejection was withdrawn in favor of the outstanding anticipation rejection.

As stated in the previous Amendment, the '947 Patent discloses composite chemical barrier films and fabrics that are useful in protective garments. They have a flexible substrate, a barrier film laminated thereon, and a polymeric material coated on the barrier film. On top of the polymeric material may be a polymeric topcoat. See col. 1 of the '947 patent.

However, the '947 Patent fails to disclose or suggest a chemical barrier fabric comprising a thermoplastic polyolefin (TPO) of the present invention coated on at least one side of a multiple layer, chemical barrier material.

More specifically, Hauer generically discloses a "thermoplastic polymeric adhesive topcoat adhered to the unlaminated side of the barrier film." For example, see the Abstract. Preferred embodiments and working examples utilize *Surllyn*® (available from DuPont) as the top coat on the claimed fabric.

Hauers' generic use of the term thermoplastic resin is not described in sufficient detail throughout the disclosure as to anticipate the present invention, or to lead one of ordinary skill in the art to modify the Hauer patent to arrive at the present invention.

It is well settled that one of ordinary skill in the art would be able to "at once envisage" the claimed species within the generic formula or description before a claim is anticipated. See MPEP § 2132.02 and *In re Petering*, 133 U.S.P.Q. 275 (CCPA 1962). Furthermore, one may look to the preferred embodiments to determine which compounds can be anticipated. *Id.*

One of ordinary skill in the polymer art typically separates polymers into two general categories: thermoplastic and thermosetting. The basis for this classification is the way in which the monomer was polymerized. Thermoplastic polymers are characterized by softening upon heating and hardening upon cooling. Thermosetting polymers do not react to heat since they are cross-linked, and rather degrade upon heating. *Surllyn*®, used as an

example in the Hauer patent, is the trade name for what is termed an "ionomer". Ionomers are a generic class of thermoplastic resins that are produced from ethylene gas and contain ionizable carboxyl groups which create ionic cross links between the polymer chains. A vast number of other subclasses of thermoplastics resins exist such as polyethylene resins, polypropylene resins, vinyl resins such as polyvinyl chloride, polyvinyl acetate, polyvinylidene chloride, polyvinyl chloride plastisols, polystyrene, styrene acrylonitrile, acrylonitrile-butadiene-styrene (ABS), polycarbonate resins, cellulosic resins such as cellulose acetate, cellulose nitrate, cellulose propionate, cellulose acetate butyrate (CAB), ethyl cellulose, acrylic resins, nylon resins, polyphenylene oxide, acetal resins, polysulfone resins, polyurethane resins, tetrafluoroethylene resins (TFE), polyimide resins, polyallomer resins, and finally, ionomers. Of this expansive list of thermoplastic resins, Hauer mentions the use of only Surlyn®, and low-density polyethylene within the embodiments.

The present situation is similar to the situation addressed in In re Meyer, 202 U.S.P.Q. 175 (CCPA 1979). There, a reference disclosing "alkaline chlorine or bromine solution" was held to embrace a large number of species and "cannot be said to anticipate" claims to "alkali metal hypochlorite." Id. Here, the generic disclosure of "thermoplastic polymer" embraces perhaps millions of species.

In view of the above, it is clear that one of ordinary skill in the art would not be motivated, from the disclosure of Hauer, to modify Hauer to arrive at the present invention.

Furthermore, as discussed in the previous amendment, any *prima facie* case of obviousness that did exist is rebutted by the comparative test data in the previously submitted Declaration by Todd Carroll under 37 C.F.R. § 1.132.

The Declaration compared examples from Hauer to the present invention and finds that the materials of the present invention exhibit superior and unexpected results when compared to the examples of Hauer.

Two commercially available embodiments of the Hauer patent which contain a *Surlyn*® coating were tested with respect to flex crack resistance using the same flex test as described in the present Specification (ISO 7854 Method B). Fabric A (Hauer) is Tychem 7500, and fabric B (Hauer) is Tychem 10,000 (both fabrics are available from DuPont). Fabric A, a high chemical barrier fabric which has a *Surlyn*® layer on the exterior surface showed an average flex crack resistance less than about 1000 cycles. Fabric B, taken from a finished garment made of Tychem 10,000 material (MarMac, Serial #406882, mfg. July 12, 1995) also contains a *Surlyn*® outer layer, and showed an average flex crack resistance less than about 1000 cycles. See the Carroll Declaration at page 6.

Additionally, the Declaration showed that embodiments of the present invention exhibited a flex crack resistance of less than 40,000. These results

are superior and unexpected, and further demonstrate that the the Hauer patent and the present application rely on significantly different thermoplastic resins, with measurable different results.

Description of Thermoplastic Polyolefins (TPOs)

There was general discussion during the interview regarding thermoplastic polyolefins (TPOs). Further to that discussion, and to reiterate what was discussed during the interview, TPOs are a relatively new subclass of thermoplastic resins, and are also known as thermoplastic polyolefin elastomers.

Unlike traditional thermoplastics, TPOs are two-component elastomer systems consisting of an elastomer such as EPDM finely dispersed in a thermoplastic polyolefin, most typically polypropylene. It is generally accepted that a generic TPO can be described as a blended compound resin containing more than 20% elastomer in polypropylene.

For the convenience of the Examiner, ATTACHMENT A contains technical information related to TPO, including background information and conference notices. If the Examiner has any remaining questions with respect to TPOs, please contact the undersigned.

Other Issues Raised During the Interview

Although not part of the outstanding rejection, the Examiner again raised concern regarding a lack of molecular weight limitations in the claims. The Examiner's concern focused on the disclosure on page 4, where it is stated that higher molecular weight resin coatings would result in a stiff fabric. Applicant reiterated his position as stated during the interview that since the present invention is directed to protective garments, tape, covers, and tent, for example, different degrees of stiffness are acceptable. Furthermore, one of ordinary skill in the art could determine the degree of stiffness desired with respect to each individual product.

Finally, the Examiner again expressed concerns as to the whether the TPO should be "halogen free". This was the subject matter of a previous rejection that has been withdrawn. The Examiner's concern was whether the Specification at page 4, lines 1-2, required the TPO to be halogen free. As stated in the Amendment following this rejection, the Specification at page 6 states that the TPOs of the present invention are generally halogen free for ease of disposal [with respect to certain applications]. As such, halogen free TPOs are not required. Furthermore, the phrase referred to by the Examiner during the interview (page 4) is an example. See the last line of page 3.

Conclusion

From the foregoing, further and favorable reconsideration in the form of a Notice of Allowance is in order and such action is earnestly solicited.

If the Examiner has any questions concerning this Amendment or the Application in general, he is respectfully urged to contact Richard S. Myers, Jr. (Reg. No. 42,022) at the number listed below.

The Commissioner is authorized to charge any deficiency or credit any overpayment in connection with this Amendment to Deposit Account No. 23-0035.

Respectfully submitted,



Richard S. Myers, Jr.
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A Professional Corporation
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Nashville, TN 37219

Attorneys for Applicant

Version With Markings to Show Claim Changes Made

Claim 1 (Five Times Amended). A composite chemical barrier fabric having improved durability comprising:

a multiple layer, chemical barrier material having a first side and a second side; and

a durability barrier layer coated on at least one of said first or second side comprising a thermoplastic polyolefin (TPO) with an inherent bonding affinity to the chemical barrier material, the coated chemical barrier composite achieving at least 25% improvement in ASTM 1342 puncture resistance and at least 25% improvement in modified ISO 7854 Method B flex-crack resistance of the fabric when compared to a fabric not having said durability barrier layer.

Claim 13 (Three Times Amended) A composite chemical barrier fabric having improved durability, comprising:

a multiple layer, chemical barrier material having a first side and a second; and

a durability barrier layer coated on at least one of said first or second side comprising a layer of a thermoplastic olefin resin (TPO) having an inherent bonding affinity to the chemical barrier material, the resin having an ASTM D1238 melt flow rate 230/2.16g/10 min of about 0.45; an ASTM D793 density

at 23 degrees Celsius g/cm³ of about 0.88; and an ASTM D1693 environmental stress-cracking resistance, hours of about >3,000.



Chemical Market Resources

Multi-Client Studies

Thermoplastic Polyolefin Elastomers, Markets, Technologies & Trends, 1999-2004

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Chemical Market Resources, Inc. (CMR) announces the release of their newest multiclient study, ***Thermoplastic Polyolefin Elastomers, Markets, Technologies & Trends, 1999-2004***. The report provides an in-depth market and end-use economics study of the TPO/TPV market in North America, Europe and Japan.

Thermoplastic polyolefin elastomers (TPOs) are compounds comprising blends of thermoplastics such as polypropylene (PP) and elastomers such as ethylene-propylene rubber (EPM) or EP(D)M rubber. The rubber phase is finely dispersed within the continuous thermoplastic phase. TPOs have performance properties equivalent to conventional thermoset rubbers and process as efficiently as thermoplastics.

The five major types of TPOs include (1) physical blends (PHY-TPO), (2) thermoplastic vulcanizates (TPV), (3) reactor-made (REC-TPO), (4) melt processible rubbers and (5) soft TPOs (subset of physical blends, TPVs and reactor blends). CMR's new study presents a general comparison among the different types of TPOs as well as a multi attribute analysis for the different types of TPOs comparing their performance properties.

TPOs are defined as a blend of thermoplastic and elastomeric phases where the elastomeric content is more than 20% by weight. In recent years, TPOs have gained increasing acceptance over other competing materials because of the global trend towards homogenization of materials usage in automotive interior and exterior applications.

Thermoplastic polyolefin elastomers have gained an edge over most thermoset rubbers because they provide faster molding cycles, lower energy consumption, closer tolerances on fabricated parts and lighter weight, and the scrap generated during processing and fabrication is recycled or reused. The recent trend towards the reduction

ATTACHMENT A

of the number of types of plastics used in automobiles for recycling purposes has accelerated development of TPOs.

In the past five years, TPOs have gained attention because of the following reasons: (1) recent developments in metallocene-catalyzed plastomers/elastomers based TPO formulations, (2) intermaterial competition among different types of TPOs and other materials, (3) developments in reactor-made TPOs and (4) development of soft TPOs that are used in applications such as roofing membranes, specialty films and others.

The major end-use markets for thermoplastic elastomeric polyolefins include 1) automotive, 2) molded goods, 3) roofing membranes, 4) wire and cable, 5) hoses and tubing, 6) medical, 7) specialty films and 8) grips. The report features 1999 demand for each end use and projects demand for 2004, separating out the data by each of the major types of material - TPOs, TPVs and plastomers/elastomers. According to the study, overall demand for thermoplastic polyolefin elastomers in North America is expected to grow at an average annual rate of 7.9%.

The study includes research on each of the technologies currently used for manufacturing TPO/TPV; a discussion on the impact of metallocene-catalyzed plastomers/elastomers; manufacturing cost analysis derived through a modular approach; and an analysis of growth drivers in the industry. Major producers are identified and profiled as well as raw material suppliers to the thermoplastic polyolefin elastomer industry. The study provides a unique perspective of the industry by identifying material requirements for major end-uses.

Also of interest, the study includes research on soft TPOs - a relatively new breed of product with excellent market potential. Soft TPOs are a subset of physical blends, TPVs and reactor made TPOs having flexural moduli ranging from 1,500 psi to 50,000 psi. These are essentially low flexural modulus materials that are used in end-use applications such as: (1) roofing membranes, (2) automotive under-the-hood applications, (3) automotive cover skins, (4) molded goods, (5) wire and cable, (6) gaskets and sealants, (7) hoses and tubing and others. Soft TPOs have gained popularity in the last two years because they have been able to expand the application horizon of

TPOs beyond automotive applications. The 1999 demand for soft TPOs in North America alone was 180 million pounds, which represents 36 MM lbs. of physical blends, 101 MM lbs. of vulcanized TPOs, and 43 MM lbs. of reactor made TPOs. These numbers are further broken down by market in the report.

Research findings conclude that roofing membranes are expected to be a high growth area for soft TPOs in North America. Other significant growth areas include soft touch grips, specialty films and some newer applications. He suggests that manufacturers of TPOs that have largely focused on automotive end-use applications should consider diversifying their product line in order to accommodate newer soft TPO applications – thus enjoying the very high growth rate levels of the past.

Published in English in December, 2000. Contains 200 pages. Price is 8,500 US dollars. An abbreviated Table of Contents follows:

Chapter 1: Executive Summary
Chapter 2: Introduction
Chapter 3: Technologies of TPOs
Chapter 4: North American Demand for TPOs
Chapter 5: North American Suppliers of TPOs
Chapter 6: European Supply and Demand
Chapter 7: Japanese and Rest of the World Supply and Demand
Chapter 8: Impact of Metallocene Catalyzed Plastomers/Elastomers
Chapter 9: Strategic Analysis

Key Exhibits: Available upon request

For further information contact Chemical Market Resources, Inc., at cmrinfo@cmrhoutex.com. or 281-333-3313 in Houston, Texas.

For additional information, comments, or questions, please contact us at cmrinfo@cmrhoutex.com.



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The emergence of two new classes of TPEs -- Polyolefin Block & Graft Copolymers and Reactor-made Thermoplastic Polyolefin -- coupled with dramatically improved means of controlled synthesis (metallocene-catalyzed polymerization) have opened up a wider range of commercial applications than ever thought possible. This intensive conference is one of the few meetings designed to address the potential of TPEs from a materials perspective. More specifically, you will benefit from the carefully chosen pool of commercial and academic speakers who will provide you with the latest advancements on physical properties, morphology, polymer structure as well as an exclusive examination of adhesion and TPE materials. These findings can be leveraged to furnish even more cost effective alternatives for plastic and rubber applications.

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- Examine metallocene catalyzed and other new classes of TPEs as potential replacements for both plastic & rubber applications
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Materials Discovery

- Graft copolymers prepared by the combination of metallocene catalysts
- Reactor-made thermoplastic polyolefin elastomers
- Fracture toughness characterization of the thermoplastic polyolefin elastomer
- Rheological behaviors of (meth)acrylate thermoplastic elastomers

Recent Advances in TPEs

- Extrusion of low density chemically foamed thermoplastic vulcanizates
- Structure-property relationships of styrenic TPEs
- Advancements made in TPE bondability

Applications

- Advantages of TPEs for medical applications
- High performance TPE for high performance applications
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CONFERENCE AGENDA

MONDAY, JUNE 28, 1999

8:00 *Registration, Coffee and Danish*

1:00 *Luncheon*

9:00 **Chairperson's Opening Remarks**
Geoffrey Holden

2:30 **Fracture Toughness
Characterization of Thermoplastic
Polyolefin Elastomers**
Chang-Sik Ha

MATERIALS DISCOVERY SESSION

9:05 **Reactor-Made Thermoplastic
Polyolefin Elastomers**
Rino Messere

3:05 **Morphology Determination
of Novel Thermoplastic
Elastomers with WAXD, SAXS and
TEM**
Shinzo Kohji

9:40 **New Polyolefin Block and Graft
Copolymers Prepared by the Combination
of Metallocene Catalysts, Chain Transfer
Agents and Reactive Comonomers**
T. C. (Mike) Chung

3:40 *Refreshment Break & Exhibit
Viewing*

10:15 **Isobutenic Block Copolymer TPEs;
Comparison of Synthetic Approaches**
Rudolf Faust

ADVANCES IN TPE MATERIAL SESSION

3:55 **Styrenic Thermoplastic
Elastomers**
Geoffrey Holden

10:50 *Refreshment Break & Exhibit Viewing*

11:10 **Thermoplastic Elastomers Based on**

4:30 **Extrusion of Low Density**

Fully (Meth)acrylate Block Copolymers
Jiangdong Tong

11:45 Anisotropy in Thermoplastic Elastomers
Barbara J. Gedeon

12:20 Characterization of The Domain Structure in Thermoplastic Elastomer Materials Using Scattering Methods
Norbert Striebeck

Chemically Foamed Thermoplastic Vulcanizates
Ryszard Brzowski

5:05 *Cocktail Reception/Cash Bar*

6:30 *Close of Day One*

TUESDAY JUNE 29, 1999

8:00 *Exhibit Viewing, Coffee and Danish*

9:00 Chairperson's Remarks
Geoffrey Holden

APPLICATIONS SESSION

9:05 Materials and Techniques for Overmolding to Rigid Substrates
Paul Zwick

9:40 Polyetherblockamides - High Performance TPE for High Performance Applications
Jörg Lohmar

10:15 Medical Applications of Thermoplastic Elastomers
Joel Williams

10:50 *Refreshment Break & Poster Viewing*

11:20 Design Considerations for Effective TPE Adhesion to Substrates
Rob Banning

11:55 BASF Develops New Product Line for Blown and Cast Film Applications
Paul David Bury

12:30 PARCEL -- A New and Unique TPV Concept for Oil Resistant Applications
Christer Bergström

1:05 Panel Discussion:
Adhesion of TPE Materials to Rigid Substrates

Moderator:
Paul Zwick

Panelists:
Rob Banning
Ryszard Brzowski
Paul David Bury
Joel Williams

1:30 *End of Conference*

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What are Thermoplastic Elastomers?

Thermoplastic Elastomers are generally lower modulus, flexible materials that can be stretched repeatedly to at least twice their original length at room temperature and are able to return to their approximate original length when stress is released. Thermoset rubber materials have been available for a long time, but currently many families of injection-moldable thermoplastic elastomers (TPEs) are replacing traditional rubbers. In addition, TPEs are widely used to modify the properties of rigid thermoplastics, usually improving the impact strength. This is quite common for sheet goods and general molding compounds.

Types of TPEs

Until as recently as 1996, the six primary TPE types could be categorized into two generic classes, block copolymers (styrenics, copolyesters, polyurethanes and polyamides) or thermoplastic/ elastomer blends & alloys (thermoplastic polyolefins and thermoplastic vulcanizates).

These traditional TPE types are known as two-phase systems. Essentially, a hard thermoplastic phase is coupled mechanically or chemically with a soft elastomer phase, resulting in a TPE that has the combined properties of the two phases.

Traditional TPE Classes

- Styrenics (S-TPE's)
- Copolyesters (COPE's)
- Polyurethanes (TPU's)
- Polyamides (PEBA's)
- Polyolefin Blends (TPO's)
- Polyolefin Alloys (TPV's)

The many classes of Thermoplastic Elastomers

In addition to the two-phase TPEs, two new technologies have emerged. They are the *metallocene-catalyzed polyolefin plastomers & elastomers*, and *reactor-made thermoplastic polyolefin elastomers*.

New TPE Entrants

- Reactor TPO's (R-TPO's)
- Polyolefin Plastomers (POP's)
- Polyolefin Elastomers (POE's)

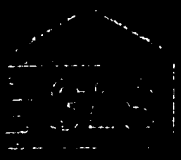
The new polyolefin plastomers (POP's) and elastomers (POE's) are

ss ntially very low molecular weight, linear low density polyethylenes (VLMW-LLDPE). A product of advancements in polymerization catalyst technology, these materials were originally slated for use in improved flexible packaging films. Recently, th se mor flexible polyethylenes have se n uses as low-cost rubb r replacements for some non-demanding molded goods applications: thos that will not be xpos d to extr mes in temperatures, pressures, loads or stress nvironments. In molded goods, these new materials are being used where "some" degree of flexibility or tactile feel is desired. They are not true elastomers!

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What are the benefits of TPE's compared to Thermoset Rubbers?

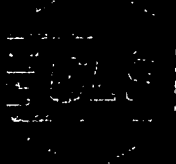
Benefits of TPEs vs. Thermoset Rubbers

- Design flexibility
- Lower fabrication costs
- Shorter processing times
- Little or no compounding required
- Scrap is fully recyclable
- Consistency of product
- Can be blow molded
- Can be thermoformed
- Lower consumption of energy
- Simpler processing
- Better control of product quality
- Broader range in product density
- Lower per-piece finished part cost
- More environmentally friendly

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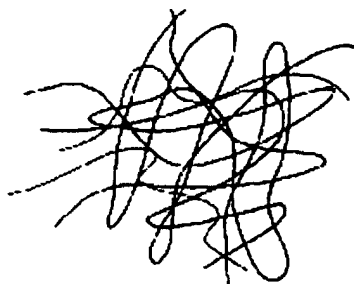
What is the difference between thermoplastic and thermoset elastomers?

Elastomers are commonly grouped into two major categories:

- Thermoplastic
- Thermoset

Structure

Thermoplastic Elastomers are materials that repeatedly soften/melt when heated and harden when cooled. Most thermoplastics are soluble in specific solvents and can burn to some degree. Softening/melt temperatures vary with polymer type and grade. Because of thermoplastics' heat/shear sensitivity, care must be taken to avoid degrading, decomposing, or igniting the material.



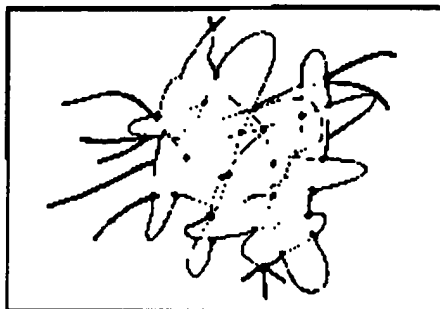
Thermoplastic Molecular Chains

Most thermoplastic molecular chains can be thought of as independent, intertwined strings resembling spaghetti (see the figure to right). When heated, the individual chains slip, causing plastic flow. When cooled, the chains of atoms and molecules are once again held firmly. When subsequently heated, the chains slip again. There are practical limitations to the number of heating/ cooling cycles to which thermoplastics can be

subjected before appearance and mechanical properties are affected.

Thermoset Elastomers undergo a chemical change during processing to become permanently insoluble and infusible. It is this chemical cross-linking that is the principal difference between thermoset and thermoplastic systems. Natural and synthetic rubbers such as latex, nitrile, millable polyurethane, silicone, butyl, and neoprene, which attain their properties through a process known as vulcanization, are typical thermoset elastomers.

As can be seen by the diagram below, when thermosets are cured or hardened, cross-links are formed between adjacent molecules, resulting in a complex, interconnected network. These cross bonds prevent the individual chains from slipping, thus preventing plastic flow when heat is added. If excessive heat is added to the thermoset elastomer after the cross-linking is complete, the polymer is degraded rather than melted. This behavior is somewhat similar to an egg when it is cooked: further heating does not return the egg to its liquid state, it only burns.



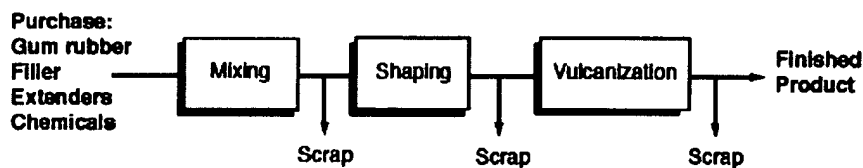
How to define processing

It is the capability to repeatedly process thermoplastic elastomers that supplies a major benefit over thermoset rubber. Key processing differences are captured in the diagrams below.

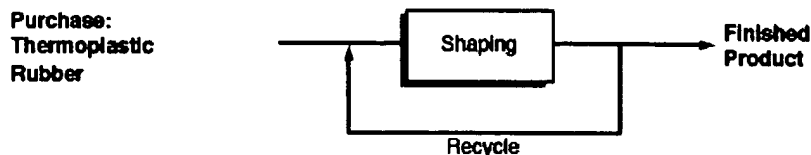
Variable	TPE	Thermoset Rubber
Fabrication	Rapid (seconds)	Slow (minutes)
Scrap	Reusable	High Percentage waste
Curing Agents	None	Required
Machinery	Conventional Thermoplastic Equipment	Special Vulcanizing Equipment
Additives	Minimal or None	Numerous Processing Aids
Design Optimization	Unlimited	Limited
Remold Parts	Yes	Unlikely
Heat Seal	Yes	No

Source: Robert Eller Associates

Conventional Rubber Products



Thermoplastic Rubber Products



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Polypropylene Cast Film: A variety of solutions

Basell offers a wide range of PP materials for the production of highly transparent and glossy cast film, with grade ranges including standard random and homopolymers as well as grades from Basell's latest catalyst and polymerisation technologies. Among the materials in the latter category are Basell's new *Clyrell* random copolymers and *Adstif* high crystallinity homopolymers. Also available are other speciality polymers that facilitate the development of new, unique properties in terms of softness (*Adflex* resins) and sealing (*Adsyl* resins). The wide range of polymers allows the production of tailored cast film for a broad array of applications. All grades are available in a variety of additive packages from barefoot to slip and anti-block combinations. By blending a variety of PP types, resin properties can be adapted according to the final application requirements.

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This site is best viewed with [Internet Explorer 4.0](#) (or higher) or [Netscape 6.0](#) (or higher).

Bibliography

Chemical Economics Handbook - The following CEH reports contain additional information that is pertinent to the subject of this report:

- Elastomers Overview
- Ethylene-Propylene Elastomers
- Polypropylene Resins

Other References - The following list of additional references is suggested for supplemental reading:

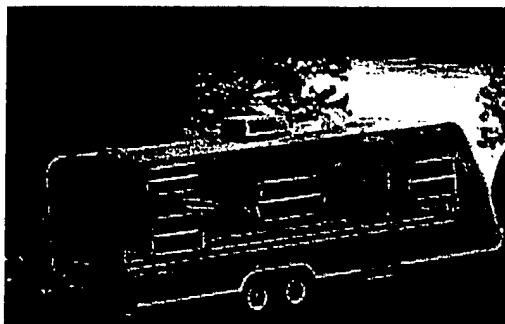
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THERMOPLASTIC POLYOLEFIN (TPO)



The polymer or plastic produced for Royal Tuff- Ply is properly referred to as a Thermoplastic Polyolefin or "TPO".

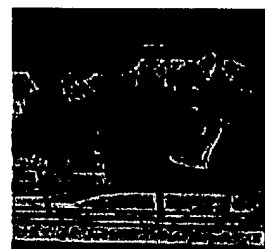
As a next generation to EPDM rubber roofing, Alpha Systems, Inc.

introduced the Royal Tuff-Ply roofing/flooring material to the RV and Marine industries in 1994. The TPO formulation being used for Royal Tuff-Ply is resistant to algae, mold, fungus, or other biological agents. Therefore, the sheet can easily be cleaned to an appearance very near its original state through the use of common cleaning agents, i.e. Murphy's Oil Soap™, and remain unaffected due to TPO's very good chemical resistance.

TPO uses special organic chemical additives for UV protection of the polymer. The chemical additives used in TPO for protection from UV light are not self-sacrificing rather they operate in a regenerative fashion as they interfere with the degradation reactions that occur from UV light exposure.

The base TPO being used to create the Royal Tuff-Ply is the very same type and quality of TPO being used by commercial roofing companies. The tear and puncture resistance of TPO sheets are typically 20-50% higher than those of EPDM rubber sheets. The repair techniques for Royal Tuff-Ply are very "environmentally friendly". TPO polymers being "plastics" can be repaired through a heat welding process.

The chemistry of the TPO allows for no chalk residue or degradation of the membrane through its useful life. TPO membranes are actually non-skid when wet and therefore are very friendly to the deck and pontoon boat industries as floor coverings.



Titanium dioxide is used in TPO for the purpose of giving finished products a very white color. TPO has special organic chemical additives for UV production of the polymer, therefore, they do not need to use extremely high levels of TiO₂ for protection of the polymer.

TPO membranes are the result of the latest advances in the field of

plastic technology and will provide many years of reliable performance in the industries they serve.

link to: [Cleaning and Maintaing the Royal Tuff-Ply™ Roof](#)

Alpha Systems, Inc. 5120 Beck Drive Elkhart, IN 46516
Phone(800)462-4698 (219) 295-5206 Fax: (219) 522-2231
karijellison@yahoo.com

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